(12) UK Patent Application (19) GB (11) 2466789 (13) A

(43) Date of A Publication 14.07.2010

(21) Application No: 0900067.0

(22) Date of Filing: 05.01.2009

(71) Applicant(s):
Greengage Lighting Limited
17 Apollo Office Court Radclive Road, Gawcott, MK18 4DF, United Kingdom

(72) Inventor(s):
John Stephen Allard
John Matcham

(74) Agent and/or Address for Service:
Kenneth Stanley Targett
48 Meadowsweet Way, HORTON HEATH, Hampshire, SO50 7PD, United Kingdom

(51) INT CL:
F21K 99/00 (2010.01) ***F21V 29/00*** (2006.01)

(56) Documents Cited:
DE 202007009655 U1 **DE 202006004833 U1**
JP 2003178602 A **US 5349509 A**
US 20080024067 A1 **US 20060043546 A1**

(58) Field of Search:
INT CL **F21K, F21V**
Other: **"ONLINE:", EPODOC, WPI**

(54) Title of the Invention: **LED lamps**
Abstract Title: **a light emitting diode lamp with heat dissipating wall**

(57) An electric lamp (10) comprises: a housing (12,14); a light emitting diode, LED, unit (22) mounted in the housing and having a pair of LED terminals (70); a pair of supply terminals (28) mounted on the housing; and electrical connections (26) connecting the supply terminals to the LED terminals. The lamp is such that, when the supply terminals are connected to a suitable supply of electricity, electricity is supplied to the LED via the electrical connections and the LED unit produces light which is projected from the housing. The housing has a heat-dissipating wall (34) against which the LED unit is disposed such that the LED unit can expand and contract substantially freely relative to the wall. The wall has holes (36) aligned with the LED terminals, and the electrical connections pass with clearance through the holes from the LED terminals to the supply terminals. The LED unit is therefore not substantially impeded in its expansion or contraction by the heat-sinking wall, or by the electrical connections to which it is connected. A flexible, thermally-conductive layer may be provided between and in contact with the LED unit and the heat-sinking wall to improve the heat transfer from the LED unit to the wall but still permit differential expansion and contraction of the LED unit and the wall.

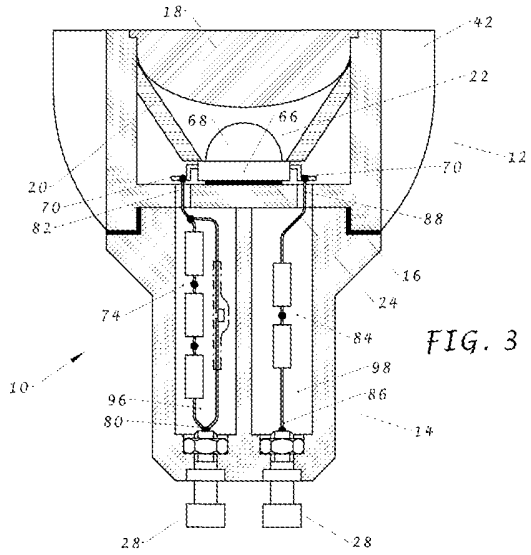


FIG. 3

GB 2466789 A

FIG. 1

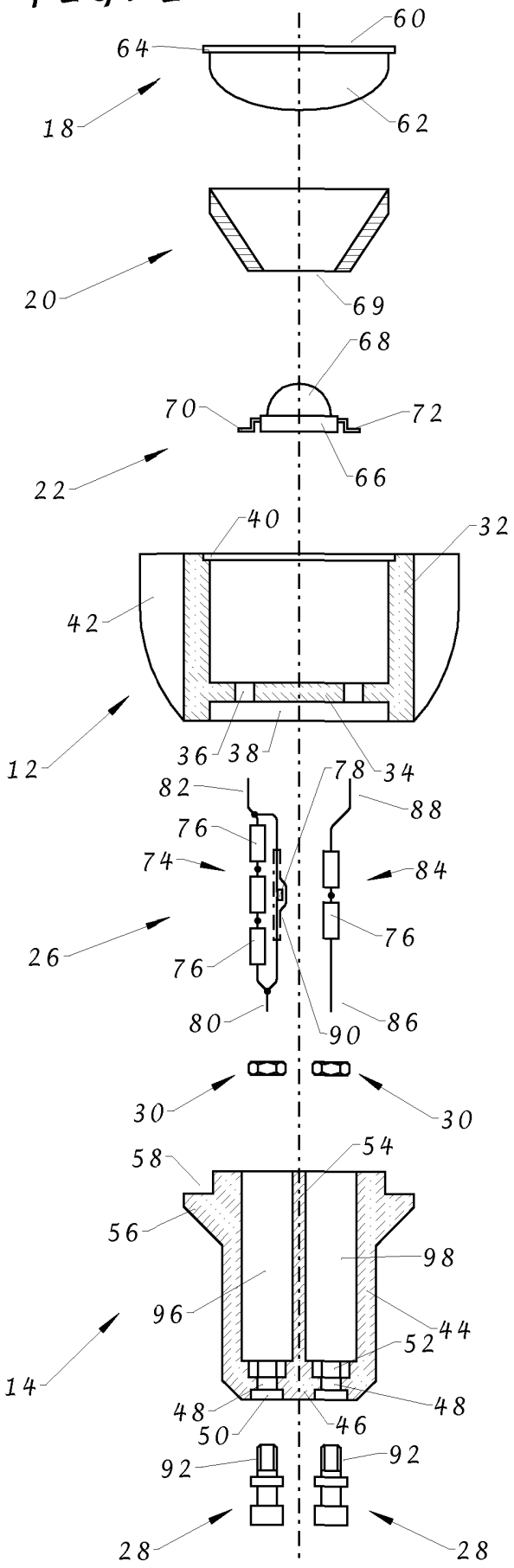
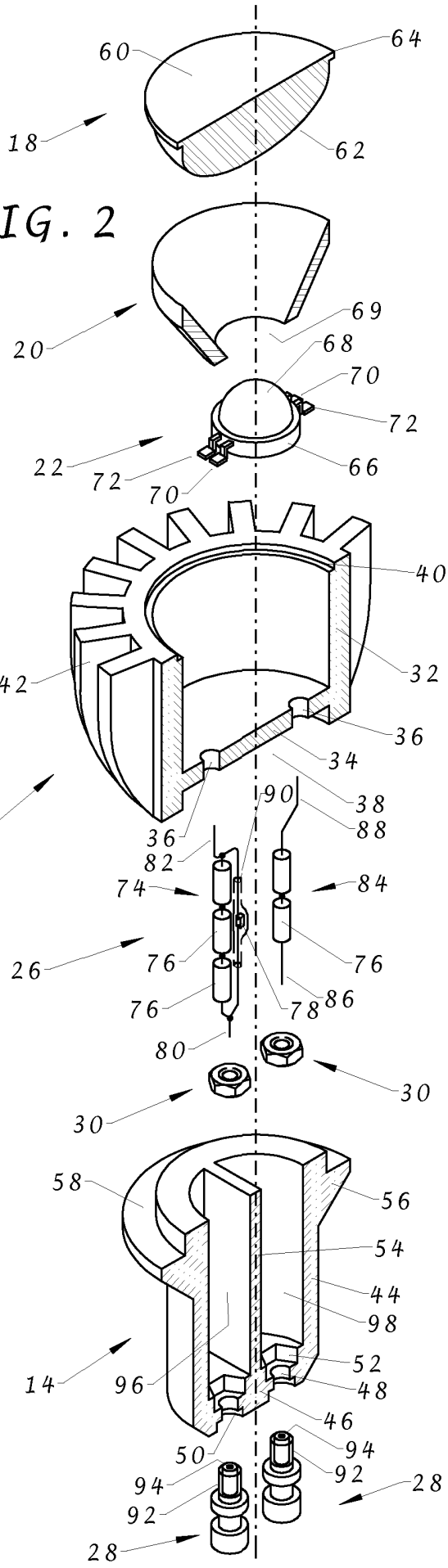

60
64
18
62
20
69
68
70
72
22
66
40
32
42
12
36
38
78
34
82
88
76
74
84
26
76
76
80
90
86
30
30
58
54
56
98
96
44
52
14
48
48
50
46
92
92
28
28

FIG. 2


60
64
18
62
20
69
68
70
72
22
72
70
66
40
32
42
36
34
12
38
90
88
36
82
84
74
26
76
76
76
78
86
80
30
30
58
56
54
44
98
14
96
52
48
46
50
94
92
28
94
92
28

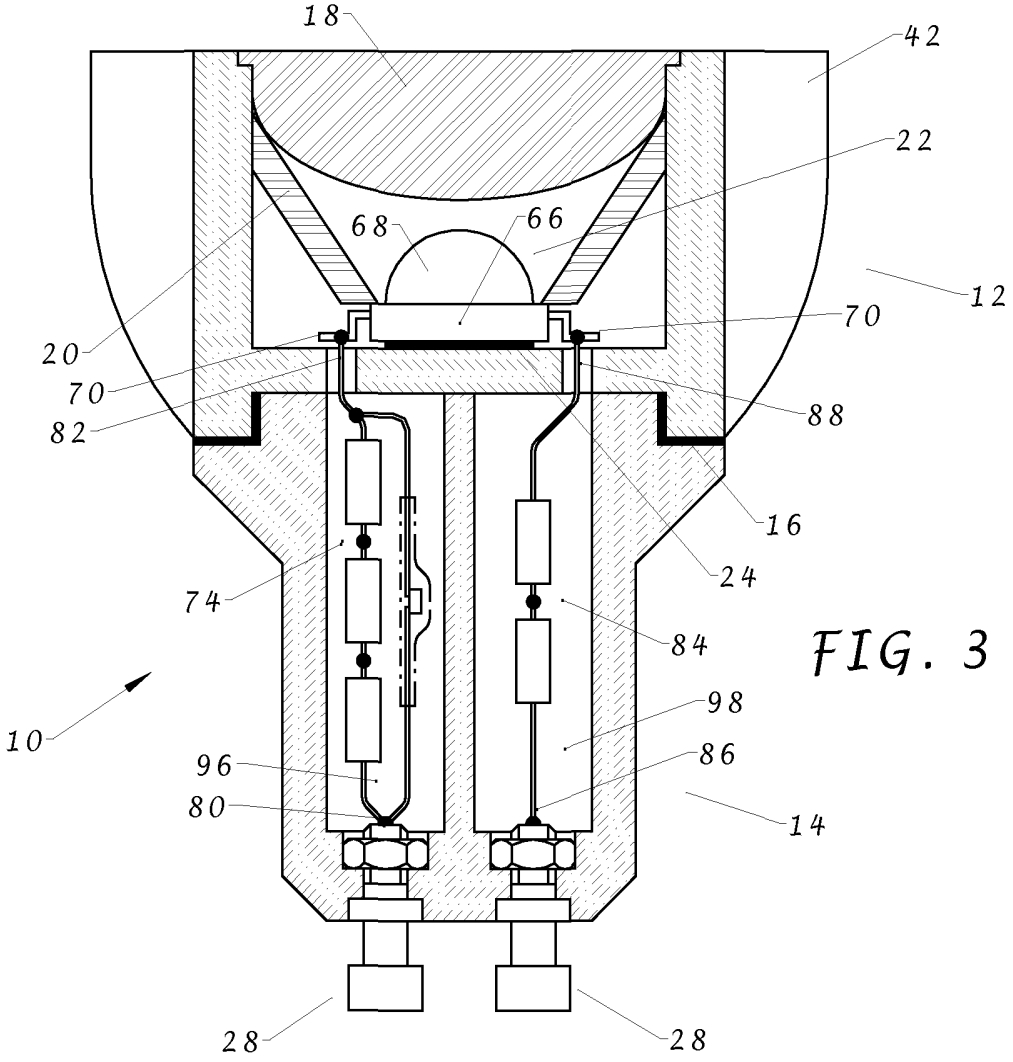

18
42
22
68
66
12
70
20
70
88
82
16
24
74
84
98
10
96
86
80
14
28
28

FIG. 3

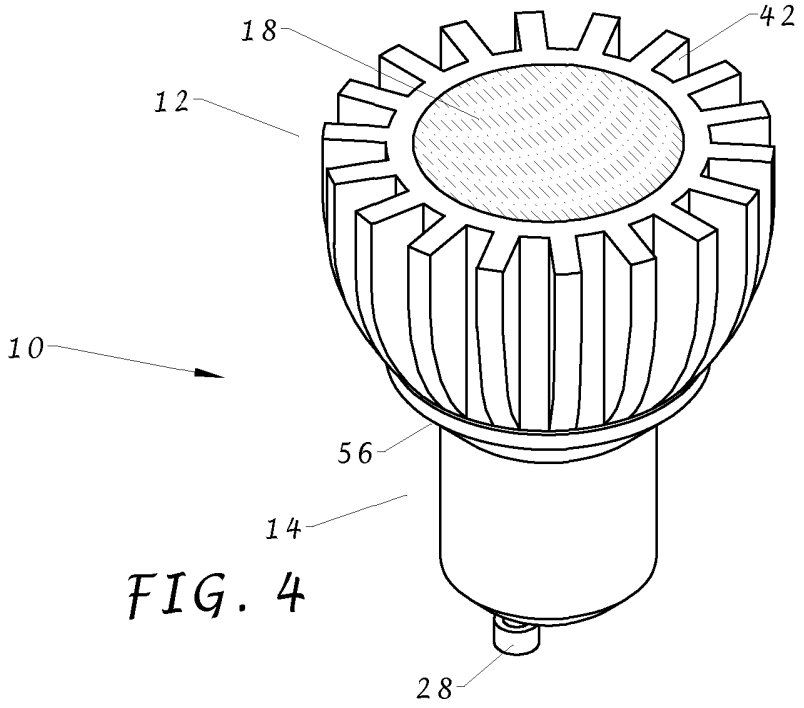

18
42
12
10
56
14
28

FIG. 4

TITLE

LED lamps

DESCRIPTION

This invention relates to LED lamps.

LED devices having a single diode junction have been known for many years and used as, for example, indicator lights. Their advantages include high efficiency and long life. Traditionally, however, disadvantages have included low light output and a restricted range of colours. More recently, LED units have been manufactured with a large number of diode junctions formed on a single substrate and connected in series. Obviously, this increases the potential light output, and the LED units can be designed to run from the mains with few additional electrical components. Also, different junctions can be designed to produce different colours, thus affecting the overall colour of light produced by the LED unit.

An example of a high voltage LED unit that has been placed on the market is the Acriche AW3220 or AN3220 manufactured by Seoul Semiconductor. It is designed to require an input voltage of about 195 V AC to draw an optimum current of 20 mA. The AW3220 or AN3220 LED unit is provided as a small package with solder pads designed for being soldered as a surface mount device, or SMD, to a heat-sinking printed circuit board. Although LEDs are efficient light producers, the AW3220 or AN3220 LED unit typically produces about 3.3 W of heat, and it is important with such a small device to dissipate that waste heat effectively, otherwise the temperature of the junctions of the LED unit will rise above the rated maximum of 125 C. Furthermore the luminous flux of the unit reduces with increasing junction temperature.

When connecting the AW3220 or AN3220 LED unit to the mains electricity in the UK, which is nominally supplied at a voltage of 230 V, it is necessary to use one or more additional components to reduce the voltage. Furthermore, the tolerance range on the mains voltage in the UK is currently from 216.2 V to 253 V, and it may therefore be desirable to include other circuit components to deal with such fluctuations. The circuit board to which the LED unit is soldered could conveniently also be used to mount and connect these additional components adjacent the LED unit. However, at an operating current of 20 mA and a supply voltage of 253 V, which is dropped to 195 V at the LED unit, the heat dissipation of these additional components, if they are resistive, is over 1 W, which adds to the thermal management problem.

The large variation in temperature of the LED unit between 'off' when the ambient temperature is low and 'on' when the ambient temperature is high, and the differential thermal expansion of the different materials of the LED unit, the printed circuit board and whatever structure the printed circuit board is mounted on can also lead to excessive stresses in the LED unit, the printed circuit board and the solder connections between them, and these excessive stresses may cause fracture and failure.

If an LED unit such as described above is to be used as a mains lamp or light bulb, it desirably needs to be packaged firstly so that it can fit a conventional mains lighting socket and secondly so that it is electrically safe.

An aim of the present invention, or at least of specific embodiments of it, is to provide an electric lamp, using an LED unit such as that discussed above, which is of simple construction, which does not cause undue stresses in the LED unit, which provides good heat transfer away from the LED unit, which is electrically safe, and which can be used as a replacement for a conventional incandescent mains electric light bulb.

In accordance with the present invention, there is provided an electric lamp comprising: a housing; an LED unit mounted in the housing and having a pair of LED terminals; a pair of supply terminals mounted on the housing; and electrical connections connecting the supply terminals to the LED terminals. The lamp is arranged such that, when the supply terminals are connected to a suitable supply of electricity, electricity is supplied to the LED via the electrical connections and the LED unit produces light which is projected from the housing. The lamp of the invention is characterised in that: the housing has a heat-dissipating wall against which the LED unit is disposed such that the LED unit can expand and contract substantially freely relative to the wall; the wall has holes aligned with the LED terminals; and the electrical connections pass with clearance through the holes from the LED terminals to the supply terminals so that the electrical connections can move within the holes. The LED unit is therefore not substantially impeded in its expansion or contraction by the heat-sinking wall, or by the electrical connections to which it is connected.

A flexible, thermally-conductive layer is preferably provided between and in contact with the LED unit and the heat-sinking wall. This layer can improve the heat transfer from the LED unit to the wall, but its flexibility permits differential expansion and contraction of the LED unit and the wall.

Preferably, the lamp is devoid of any circuit board on which the LED unit is mounted.

The housing preferably has a plurality of heat-dissipating fins. In this case, the wall and the fins are preferably integrally formed from the same piece of material so as to avoid a thermal barrier between the two.

The lamp may further include a reflector mounted in the housing, the reflector having an aperture through which the LED unit projects. In this case, the reflector may be arranged to bear on the LED unit such that the LED unit can expand and contract laterally substantially freely relative to the reflector. The reflector and at least a portion of the housing in which the reflector is mounted are preferably partially translucent. The housing can therefore glow pleasantly when the lamp is in operation.

The electrical connections may include at least one electrical component (such as a voltage dropping resistor and/or a protection device. In this case, the electrical component is preferably disposed to the opposite side of the heat-sinking wall relative to the LED unit, so that any heating effect of the electrical component has a lesser effect on the temperature of the LED unit. In an embodiment of the invention, the housing provides a passageway between one of the supply terminals and one of the LED terminals, and the electrical component, or at least one of the electrical components, is suspended in the passageway without being bodily mounted onto a circuit board. The housing may also provide another passageway between the other supply terminal and the other LED terminal, and, in this case, at least one other of the electrical components may be suspended in said other passageway without being bodily mounted onto a circuit board. It is therefore possible to avoid the use of any circuit boards at all and to avoid the toxins which arise in the production of printed circuit boards. The passageways are preferably separated by a dividing wall of the housing so as to electrically isolate the components in the two passageways.

The LED unit preferably comprises a plurality of light-emitting diode-junctions and is devoid of any other electronic components.

In an embodiment of the invention, the housing comprises first and second housing portions, the LED unit being mounted in the first housing portion, and the supply terminals being mounted on the second housing portion.

The housing is preferably formed of an alumina ceramic material, which can withstand high temperatures, has high heat conductivity and high electrical resistivity.

The housing and supply terminals are preferably sized and configured to fit a standard mains lighting socket, such as a socket designated GU10, BC, ES, SBC or SES.

A specific embodiment of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an exploded part-sectioned side view of a spotlight;

Figure 2 is an exploded part-sectioned isometric view of the spotlight;

Figure 3 is a sectioned side view of the assembled spotlight to a larger scale; and

Figure 4 is an isometric view of the assembled spotlight.

Referring to the drawings, a GU10 spotlight 10 comprises: front and rear body portions 12,14 secured together by a layer of adhesive 16; a lens 18; a reflector 20; an LED unit 22 secured in position by its electrical connections and with a thermally-conductive, flexible layer 24 interposed between the LED unit 22 and the front body portion 12; electrical circuit components 26; a pair of supply terminals 28; and a pair of terminal nuts 30.

The front and rear body portions 12,14 are formed from an alumina ceramic material known as "alumina 98" which can withstand high temperatures, has high heat conductivity, high electrical resistivity and is slightly translucent.

The front housing portion 12 has a cylindrical wall 32 closed adjacent its rear end by a rear wall 34 formed with a pair of holes 36. A shallow recess 38 is formed behind the rear wall 34. The front end of the cylindrical wall 32 is formed with an internal rebate 40. A plurality of heat-dissipating fins 42 radiate from the cylindrical wall 32.

The rear housing portion 14 has a cylindrical wall 44 closed at its rear end by a rear wall 46 formed with a pair of holes 48. The holes 48 each have a circular recess 50 on the outside and a hexagonal recess 52 on the inside. The rear housing portion 14 is formed with a central longitudinal dividing wall 54. Adjacent its front end, the cylindrical wall 44 is formed with an external flange 56 and shoulder 58.

The lens 16 is made from transparent polycarbonate and has a flat front face 60 and a convex rear face 62. A flange 64 is formed externally around the lens 16 and is sized to fit the rebate 40 of the front housing portion 12.

The reflector 20 is made from a white plastics material which is slightly translucent. The reflector is generally frustoconical, having a maximum diameter which is a snug fit inside the cylindrical wall 32 of the front housing portion 12.

The LED unit 22 has a disc-shaped heat-sinking base 66 onto which a semi-spherical lens 68 is formed. The lens 68 is slightly smaller in diameter than the internal diameter of the hole 69 at the rear end of the reflector 20. A large number of LEDs (not shown) are formed on the base 66 under the lens 68. The LEDs are series connected between a pair of solder pads 70. Other non-connected solder pads 72 may also be provided. An example of the LED unit 22 is the Acriche AW3220 or AN3220 manufactured by Seoul Semiconductor. That LED unit does not have any electronic components other than the LEDs themselves.

The electrical circuit components 26 comprise: a first string 74 of three series-connected fused resistors 76 connected in parallel with a positive temperature coefficient thermistor 78 between two wire ends 80,82; and a second string 84 of two series-connected fused resistors 76 between two wire ends 86,88. The thermistor 78 is contained in an insulating sheath 90. When the Acriche AW3220 or AN3220 is to be powered by a 230V AC mains supply, the resistors 76 preferably have a rating of 1 kOhm, ¼ Watt, and an example of the thermistor 78 is a PRG18BB471MB1RB manufactured by Murata Manufacturing Co., Ltd., which has a nominal cold resistance of 470 Ohms.

The rear, exposed ends of the terminals 28 are of standard GU10 design. The front ends of the terminals 28 have screw threads 92 to receive the nuts 30 and are formed with holes 94.

In order to assemble the spotlight 10, the terminals 28 are fixed into the holes 48 by the nuts 30. The electrical component chains 74,84 are then inserted into the rear body portion 14 to either side of the central wall 54, and the rear ends 80,86 of the electrical component chains 74,84 and then soldered or crimped into the holes 94 in the respective terminals 28. The layer of adhesive 16 is then applied around the shoulder 58 of the rear housing portion 14, and the front housing portion 12 is offered up to the rear housing portion 14 with the front ends 82,88 of the electrical component chains 74,84 being guided through the holes 36 in the rear wall 34 of the front housing portion 12. The front end of the cylindrical wall 44 of the rear housing portion 14 fits into the recess 38 of the front housing portion 12, and the layer of adhesive 16 bonds the front and rear housing portions 12,14 together. A suitable adhesive for the layer 16 is Nusil R31-2186, which is a two-part, translucent, high tear-strength, silicone adhesive having an operating temperature range up to 240 C. The thermally-conductive layer 24 is then applied to the underside of the base 66 of the LED unit 22, and the LED unit 22 is placed in position on

the rear wall 34 of the front housing portion 12 with the pads 70 adjacent the front ends 82,88 of the chains 74,84 of electrical components. A suitable material for the layer 24 is Nusil R-2930, which is two-part, white, thermally-conductive silicone. It may be used in conjunction with a primer such as Nusil CF6-135. The front ends 82,88 of the chains 74,84 of electrical components are then soldered to the pads 70 of the LED unit 22. The reflector 20 is then inserted into the front housing portion 12, and the lens 18 is placed in position and held with its flange 64 in the rebate 40 by any suitable means, such as adhesive or a friction fit.

It will be noted that, once assembled, the rear housing portion 14 forms two parallel passageways 96,98 extending between the supply terminals 28 and the rear wall 34 of the front housing portion 12. The passageways 96,98 are separated by the central wall 54 of the rear housing portion 14 and contain the strings 74,84 of electrical components, which are therefore electrically isolated from each other.

It should also be noted that the holes 36 in the rear wall 34 of the front housing portion 12 are substantially larger in diameter than the wire ends 82,88 of the strings 74,84 of electrical components. Also, the thermally-conductive layer 24 between the base 66 of the LED unit 22 and the rear wall 34 of the front housing portion 12 is flexible. Furthermore, although the rear end of the reflector 20 may bear on the base 66 of the LED unit 22 around the lens 68, the reflector is not bonded to the base 66 of the LED unit 22. All of these features allow the LED unit 22 to expand and contract laterally, as a result of the great variations in temperature that it experiences, without any substantial impediment, and therefore no substantial external stress is applied to the LED unit 22 with changes in its temperature.

In operation, the spotlight 10 is fitted to a standard GU10 mains lighting socket. Mains electricity at a nominal voltage of, for example, 230V AC is applied to the supply terminals 28, and current flows through the strings 74,84 of electrical components and the LED unit 22, so that the LED unit 22 produces light which is projected through the lens 18 guided by the reflector 20. Due to the slight translucency of the reflector 20 and front housing portion 12, the fins 42 of the front housing portion 12 glow as a design feature. During normal operation of the Acriche AW3220 or AN3220, it requires a voltage of about 195V AC across the LED pads 70 in order to draw a preferred current of 20mA, and the combined effect of the resistors 76 and the thermistor 78 is to produce that voltage at the LED pads 70. However, the thermistor 78 serves to increase the resistance of the circuit and therefore reduce the current drawn in the event that the temperature of the spotlight 10 rises above its normal operating temperature and/or current through the thermistor 78 rises above the normal operating current, as a result

of, for example, a fault in the spotlight 10 or an excessive voltage supplied to the supply terminals 28. It should also be noted that, in the event of a significant over-current, one or more of the resistors 76 will fuse.

The heat produced by the LED unit 22 is conducted through the thermally-conductive layer 24 to the rear wall 34 of the front housing portion 12 and thence to the cylindrical wall 32 and the heat-dissipating fins 42.

It should be noted that the embodiment of the invention has been described above purely by way of example and that many modifications and developments may be made thereto within the scope of the present invention.

CLAIMS

(The reference numerals in the claims are not intended to limit the scope of the claims.)

1. An electric lamp (10) comprising:
a housing (12,14);
an LED unit (22) mounted in the housing and having a pair of LED terminals (70);
a pair of supply terminals (28) mounted on the housing; and
electrical connections (26) connecting the supply terminals to the LED terminals;
the lamp being such that, when the supply terminals are connected to a suitable supply of electricity, electricity is supplied to the LED via the electrical connections and the LED unit produces light which is projected from the housing;
characterised in that:
the housing has a heat-dissipating wall (34) against which the LED unit is disposed such that the LED unit can expand and contract substantially freely relative to the wall;
the wall has holes (36) aligned with the LED terminals; and
the electrical connections pass with clearance through the holes from the LED terminals to the supply terminals.

2. A lamp as claimed in claim 1, wherein a flexible, thermally-conductive layer (24) is provided between and in contact with the LED unit and the heat-sinking wall.

3. A lamp as claimed in claim 1 or 2, wherein the lamp is devoid of any circuit board on which the LED unit is mounted.

4. A lamp as claimed in any preceding claim, wherein the housing has a plurality of heat-dissipating fins (42).

5. A lamp as claimed in claim 4, wherein the heat-dissipating wall and the heat-dissipating fins are integrally formed from the same piece (12) of material.

6. A lamp as claimed in any preceding claim, further including a reflector (20) mounted in the housing, the reflector having an aperture (69) through which the LED unit projects.

7. A lamp as claimed in claim 6, wherein the reflector bears on the LED unit such that the LED unit can expand and contract laterally substantially freely relative to the reflector.

8. A lamp as claimed in claim 6 or 7, wherein the reflector and at least a portion of the housing in which the reflector is mounted are partially translucent.

9. A lamp as claimed in any preceding claim, wherein the electrical connections include at least one electrical component (76,78) disposed to the opposite side of the heat-dissipating wall relative to the LED unit.

10. A lamp as claimed in claim 9, wherein at least one of the electrical components is a resistor (76).

11. A lamp as claimed in claim 9 or 10, wherein at least one of the electrical components is a thermistor (78).

12. A lamp as claimed in any of claims 9 to 11, wherein:
the housing provides a passageway (96) between one of the supply terminals and one of the LED terminals; and
the electrical component, or at least one of the electrical components, is suspended in the passageway without being bodily mounted onto a circuit board.

13. A lamp as claimed in claim 12, wherein the housing provides another passageway (98) between the other supply terminal and the other LED terminal.

14. A lamp as claimed in claim 13, wherein at least one other of the electrical components is suspended in said other passageway without being bodily mounted onto a circuit board.

15. A lamp as claimed in claim 13 or 14, wherein the passageways are separated by a dividing wall (54) of the housing.

16. A lamp as claimed in any preceding claim, wherein the LED unit comprises a plurality of light-emitting diode-junctions and is devoid of any other electronic components.

17. A lamp as claimed in any preceding claim, wherein the housing comprises first and second housing portions (12,14), the LED unit being mounted in the first housing portion (12), and the supply terminals being mounted on the second housing portion (14).

18. A lamp as claimed in any preceding claim, wherein the housing is formed of an alumina ceramic material.

19. A lamp as claimed in any preceding claim, wherein the housing and supply terminals are sized and configured to fit a standard mains lighting socket.

20. An electric lamp substantially as described with reference to the drawings.

Application No: GB0900067.0 **Examiner:** Alessandro Potenza

Claims searched: 1-20 **Date of search:** 30 April 2009

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1-20	DE202006004833 U1 (HUANG HSIEN JUNG) see figure 3 and English language abstract
Y	1-20	US5349509 A (EBT LICHT TECHNIK GMBH) see figure 1 and description from column 3 line 19 to column 4 line 11
A	-	JP2003178602 A (KOITO MFG CO LTD) see figure 2
A	-	US2008/024067 A1 (ISHIBASHI KAZUO) see figure 2
A	-	US2006/043546 A1 (KRAUS ROBERT) see figure 4
A	-	DE202007009655 U1 (AEON LIGHTING TECHNOLOGY INC) see figure 4

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F21K; F21V

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F21K	0007/00	01/01/2006
F21V	0029/00	01/01/2006